

## Student Worksheet

Name(s): \_\_\_\_\_  
\_\_\_\_\_

Section: \_\_\_\_\_  
Date: \_\_\_\_\_

## Simple Machines

### Activity Two: The Inclined Plane and Pulley

## Lesson One: The Inclined Plane

## Getting Started:

1. With your partner, think of as many examples of inclined planes as you can. Record your list.

### Lab Instruction:

2. Select a length for the inclined plane.

Record the length, effort force and indicate whether or not it was successful.

Repeat using various lengths.

## Data Collection

### Table 1: Inclined Plane

[illegible]

- What is the length of this inclined plane?
4. Would this be the ideal length to use for the inclined plane?
  5. What other factors might you consider?
  6. Defend your choice for the ideal length. Give your reasons in complete sentences.
  7. Transfer the data for length and effort from Table 1 onto Table 2.
  8. Calculate the amount of work done to get the stone to the top of each inclined plane.  
Remember:  $\text{Work} = \text{Force applied} \times \text{distance mass is moved}$

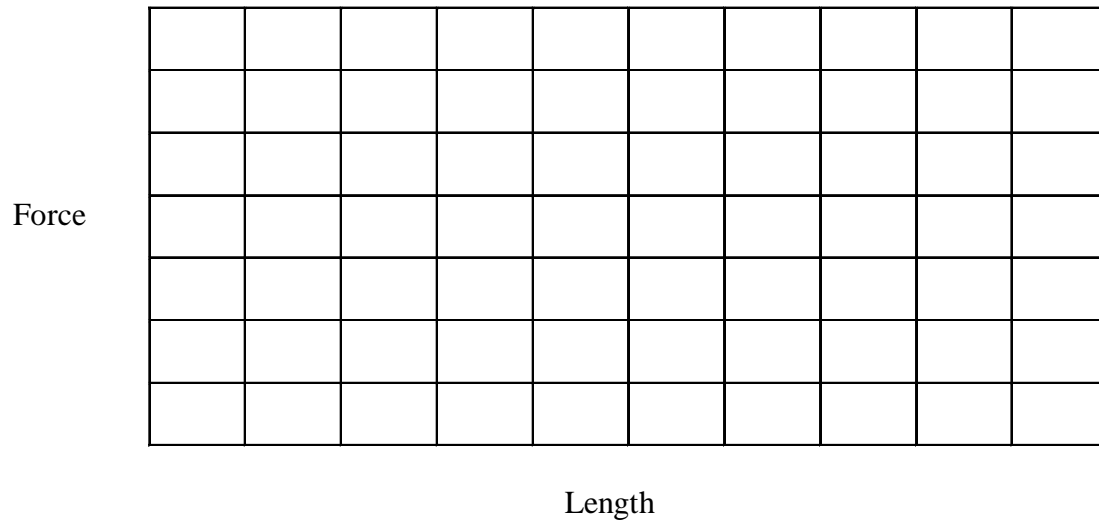
Effort Force (N)      X      Distance (m)      =      Work Nm (J)

[illegible]

9. How do the values of work found for the various lengths of inclined plane compare? Use complete sentences in your answer.

#### Graphing Data

10. Label the graph and plot the data from Table 1



11. Describe the arrangement of points on your graph in words.

12. What happens to the effort force needed as the length of the inclined plane increases?

13. What do we call this kind of relationship?

14. Using the information you have just collected, in your own words explain the advantage gained by using an inclined plane to raise an object.

### The Wedge Connection

15. Confer with your partner and make a list of how the wedge and the inclined plane are similar. (Be sure to consider both form and function)

16. What happens to the stone as Harry pulls the inclined plane toward himself?

17. In what direction is Harry applying the force?

18. In what direction is the force acting on the stone?

19. What is moving the most, the inclined plane or the stone?

Discuss what you have just done with your partner:

Remember:  $\text{Work} = \text{force} \times \text{distance the force moves}$

20. Predict which force is greater: the force Harry is applying to the magical weightless inclined plane or the force acting on the stone? Explain your answer using complete sentences.

## Lesson 2: Pulleys

21. Why do you think Pic's experiment worked? Discuss this with your partner, then record your best explanation using complete sentences.

### Data Collection

22. Record the number of supporting ropes, the effort force applied to the rope, and the distance the rope is pulled on Table 3.

Record the data for all 4 available arrangements.

Table 3

| # of supporting ropes | Force applied | Length of rope pulled | Work Input |
|-----------------------|---------------|-----------------------|------------|
|                       |               |                       |            |
|                       |               |                       |            |
|                       |               |                       |            |
|                       |               |                       |            |

23. The work output for all tests is equal to the product of the weight and the distance the weight is lifted:  $3480 \text{ N} \times 1.3 \text{ m} = 4524 \text{ Nm}$ . Calculate the work input of each trial. Compare your 5 values for work and using complete sentences describe what you found.

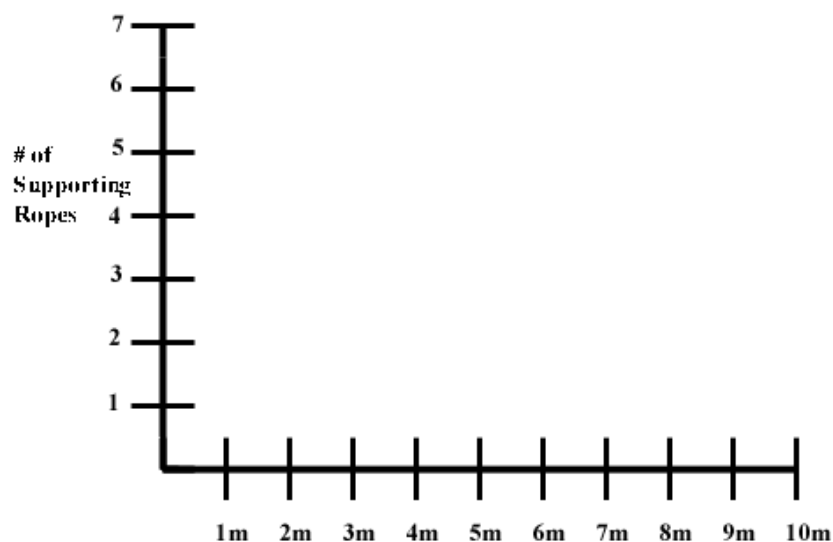
24. Transfer the data needed from Table 3 to Table 4 and calculate the mechanical advantage (MA) for each of the pulley systems used.

| # of supporting ropes | Resistance Force | / | Effort Force | = | MA |
|-----------------------|------------------|---|--------------|---|----|
| 1                     | 3480             |   |              |   |    |
| 2                     | 3480             |   |              |   |    |
| 3                     | 3480             |   |              |   |    |
| 4                     | 3480             |   |              |   |    |

25. Use complete sentences to describe the relationship between the # of supporting ropes and the mechanical advantage of a pulley system.

26. Use the number of supporting ropes and the length of rope used to lift our stone to complete this graph.

**Graph A**

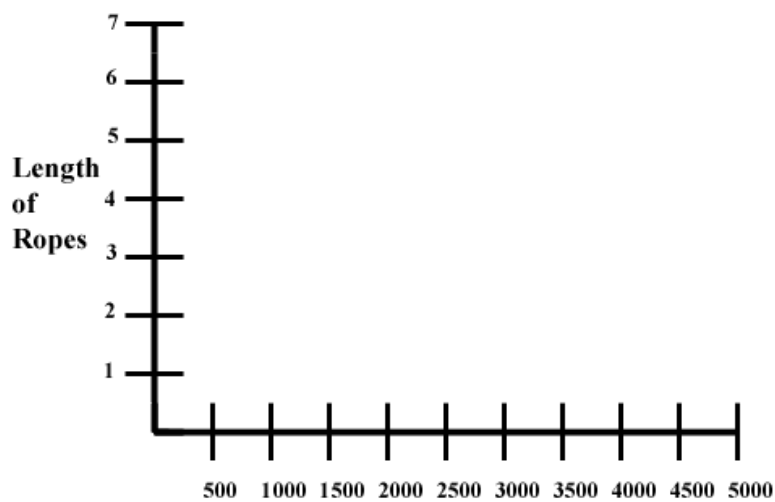


27. As the number of supporting ropes on the pulley increases what happens to the length of rope that must be pulled to lift the stone into place?

28. Using this graph, predict the length of rope that would be pulled if you were using 5 supporting ropes.

29. Use the force applied in each test and the length of the force was pulled to complete this graph.

**Graph B**

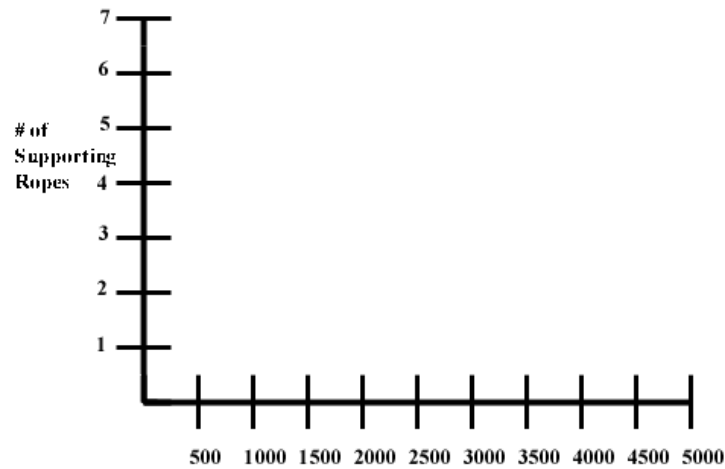


30. As the amount of force increases what happens to the length of rope pulled?

31. Predict the force if the length of rope pulled had been 7 meters.

32. Use the number of supporting ropes and the force applied to complete graph C.

**Graph C**



33. As the number of supporting ropes increases, what happens to the amount of force applied?

34. Predict the force needed if 5 supporting ropes were used.

35. Was this prediction as easy to make as the predictions using graphs A and B? Explain your answer using complete sentences.

36. With your partner, compare the patterns formed by the points on each of the graphs. Using complete sentences describe the pattern of each graph and what that pattern tells you.



### Lesson 3 – Cooperation

37. With your partner discuss all of the variables available in this type of combined system. List the variables you thought of and explain what each type of change would do to the mechanical advantage. Be sure to answer using complete sentences.

#### Data Collection

38. Select a length for the ramp by dragging the tip of the ramp to the length you choose. Test each of the four possible pulley selections for this ramp and record the information on Table 4.
39. Select a different length for the ramp and test each of the pulley selections. Record this data in Table 4 also.

Table 4

| # of supporting ropes | Length of Ramp | Force (N) | MA<br>Resistance/effort<br>Force |
|-----------------------|----------------|-----------|----------------------------------|
| 1                     |                |           |                                  |
| 2                     |                |           |                                  |
| 3                     |                |           |                                  |
| 4                     |                |           |                                  |
| 1                     |                |           |                                  |
| 2                     |                |           |                                  |
| 3                     |                |           |                                  |
| 4                     |                |           |                                  |

40. In each trial, how does the input force compare to the weight of the stone?

Weight [Resistance force (3480 N)] divided by effort force equals mechanical advantage.

41. Calculate the system mechanical advantage for each of your tests.

Select one line of data from Table 4:

42. Calculate the MA of the inclined plane. [ramp length divided by ramp height (1.3)]

43. Calculate the MA for the pulley system.

44. Select a second line of data from Table 4 and calculate the MA for the inclined plane and the pulley as you did above.

Work Space

45. Compare these values with the MA you recorded for the same systems on Table 4.

46. Discuss your results with your partner. Using full sentences, describe what happens to the mechanical advantage when you combine simple machines.

Challenge: Design 2 different inclined plane and pulley systems which will allow Pic and Harry to each raise a stone the same distance while using the same effort forces.